Maximum Utility for Minimum Cost:
Simple Structural Methods for Stormwater Quality Improvement

T. J. Mullen
President, Best Management Products, Inc.

Abstract

Stormwater runoff is characterized by the United States Environmental Protection Agency as "one of the greatest remaining sources of water pollution" in America (United States Environmental Protection Agency, November 1999). Thus, efforts to implement stormwater quality improvement regulations are accelerating across the United States, compelling municipalities and land developers to maximize the usefulness of stormwater infrastructure as never before. With simple modifications to current designs, common catch basins and other stormwater structures can be more effectively utilized as pollution control devices, rather than merely as a way to move stormwater. Future systems must drain runoff which cannot be infiltrated to areas where it can be appropriately managed, and simultaneously, reduce the environmental impact of the ultimate discharge to the receiving waters. Adding a deep sump to catch basins, a common feature in some areas of the country, has been shown to remove some sediments and gross particles. As an additional benefit, these structures allow the use of an outlet hood or baffle, which can drastically reduce the discharge of floatable debris and trash, and aid in the removal of free oil and grease. This "cleaner" runoff can also extend the service life of a traditional stormwater detention facility, such as a pond, or a retention facility, such as a groundwater recharge area. This paper addresses a group of low-cost components which comprise the SNOUT® Stormwater Quality Control System, manufactured by Best Management Products, Inc. (BMP, Inc.) The applications include a deep sump catch basin with an outlet hood, a structure with an outlet hood and flow restrictor, structures configured to bypass high flows, and outlet controls which can accommodate extreme flow conditions while retaining captured pollutants.

Background

Catch basins, stormwater inlets, and other specialized structures have a long history of use as part of municipal separate storm sewer systems (MS4s) in controlling stormwater runoff. So too have the many devices used with them to aid in the removal of pollutants, such as grates, traps, hoods, and sumps. With the aid of new appurtenances based on older concepts, these simple structures are being more effectively used and maintained as a first line of defense against non-point source pollution in urbanized areas to improve stormwater quality.

In its simplest form, a stormwater inlet's primary function is to intercept sheet flows in order to prevent the accumulation of stormwater in an area where flooding could impede traffic or pedestrians, cause property damage, or otherwise present a nuisance. However, these inlets to MS4s or combined sewer systems (CSSs) are often the entry point of pollutants from diffuse sources found in stormwater runoff. As a result, pollution is often discharged untreated, directly into our surface waters.

The use of deep sumped structures, as part of the stormwater system along with simple components essentially creates numerous "micro-detention" nodes throughout a stormwater conveyance, and allows moderate levels of pollutants to be captured in an economical manner. Typically, this method requires much lower on-going maintenance needs than traditional "tray-type" catch basin inserts or baskets, and a significantly lower capital cost than most "end-of-pipe" controls. Further, the ability of sufficiently sumped structures to intercept gross-pollutants and finer particles such as suspended solids (SS) has been well documented. A recent study in New Jersey found an average SS capture rate of 32 percent over several storm events (Pitt and Field, 1998).

Capture of trash, floatables and other gross-pollutants have also been widely recognized as a benefit of an inlet with a hood. A 1995 study of New York City catch basins compared the relative effectiveness of structures with and without hoods. The hooded structures captured 85 percent of the litter that entered the combined sewer inlets compared to 30 percent for the catch basins without hoods (New York City Department of Environmental Protection, 1995, cited in EPA Doc. 832-F99-008 September 1999). The nation's first Total Maximum Daily Load (TMDL) for trash, being established for the Los Angeles River Basin, calls for reductions in gross-pollutant loading. Other areas of the country are expected to follow this lead (Will Shuck, Long Beach Press-Telegram, 2001).

Until recently, the devices available for use as hoods or traps were mainly limited to metal hoods, metal or PVC elbows, and tees. While many of these devices have been in service for decades, little design effort was given to these appurtenances in terms of pollutant removal performance, hydraulic efficiency, or ease of installation. That situation has changed with a versatile product line available from Best Management Products, Inc. of Lyme, CT. Relative to the traditional hoods or fittings, which lack an oil-proof gasket or an anti-siphon vent, the new design transforms the hood concept into a higher performance, multi-task stormwater quality and quantity control system. This system, the SNOUT® Stormwater Quality Control System (US Patent # 6126817), uses vented plastic-composite hoods and related components to improve water quality and control flow quantity.

System Advantages

- SNOUT® hoods use an oil tight gasket sealing system around perimeter of unit.
- Anti-siphon vent prevents pollutants from being drawn downstream in full flows.
- Watertight access port allows easy pipe inspection and maintenance.
- Light Weight/High Strength composite construction is durable and easy to install.
- Sizes to fit over outlet pipes up to 96" outside diameter.
- Highly flexible low-cost component system with a variety of accessories including Flow Restrictors, Oil Absorbents, Flow Deflectors, and Odor Filters.
- SNOUT® components can be used to construct a wide variety of stormwater quality structures including those with high flow bypass, swirl chambers, and outlet flow control.
- Use of sumps and SNOUT® hoods keeps pipes cleaner, thus reducing pipe maintenance.

Since this system became commercially available in 1999, more than 7,000 SNOUT® hoods have been installed. Initial results have been quite favorable. SNOUT® systems have been or will be installed as part of research or monitoring projects in the following locations:

Washington, D.C., Navy Yard, Center for Low Impact Development
Bryn Mawr, PA, Regional Stormwater Facility, Yerkes Associates, Designer
Harvey's Lake Demonstration Project, Harvey's Lake, PA, PA DEP and Princeton Hydro, LLC

Data collected from these and other projects will be incorporated on an on-going basis on the BMP, Inc. website at www.bmpinc.com, along with selected case studies and photos from a variety of projects.

Applications

A variety of applications and SNOUT® system configurations exist in the field. Each has its advantages and disadvantages, which are outlined below. These systems include:

Catch Basin with an Outlet Hood- This is the most basic application. This system combines a sumped catch basin with a hood. It is useful for capturing trash and floatables, and modest levels of free oils, and sediment. These structures can be inlet-only, or in-line with other structures. To increase oil retention, oil absorbent booms can be placed in the structure. This application has limitations based primarily on the volume and sump depth of the structure itself. To minimize re-suspension of finer captured solids, a deep sump, with a minimum depth of 4 feet, or a depth equal to 3X the outlet pipe inside diameter is recommended. (see Figure 1)

In-line Catch Basin with a Hood and Flow Restrictor- This application is useful for limiting the discharge rates down stream. A micro-detention node can be created using a flow restrictor, making use of the storage volume in pipes upstream or ponding areas above the inlet. It is also used in outlet structures in detention basins. Discharge rates can be accurately controlled by slot or orifice dimensions in the riser pipe shielded inside a SNOUT® hood, making it difficult to clog with floating debris. The structure must receive periodic maintenance to ensure that sediment accumulation does not reach entrance to riser pipe. is designed to provide absolute flow control. A caution to the designer is that this in-line application does not provide for overflow other than that which can flow over the open top of the riser pipe. For installations where occasional flooding cannot be tolerated, the design shown in Figure 5, *Outlet Structure with Overflow*, should be used. (see Figure 2)

Structures in Series with Oil Absorbent is and Flow Deflector Plates- This application is intended for use as a terminal structure on a site where higher than normal pollutant loads may be present. Stormwater makes a "multiple pass" through deep sump structures with hoods and accessories. Accessories include oil absorbent booms for increased oil retention, and deflector plates for increased solids removal. This application is also an excellent pre-treatment design prior to discharge to a conventional stormwater BMP. Limitations are based primarily on structure sizes, whereby larger structures with deeper sumps will yield better removals. (see Figure 3)

Bypass Structure Configuration- This design combines the features of structures in series, but allows for high flows to be bypassed from the primary treatment structures. All stormwater receives some treatment however, as the terminal structure contains a large SNOUT® hood and a deep sump. Limitations are primarily that multiple structures must be utilized to perform the bypass, but they can be configured in a wide variety of ways such that hydraulic grade lines are maintained. (see Figure 4)

Outlet Structure with Overflow - This design combines accurate outlet control with the SNOUT® flow restrictor as well as an overflow mode that maintains capture of floatable pollutants and trash. Limitations may be based primarily on the outlet structure size, as to accommodate large flows, large size SNOUT® hoods must be used which require large structures that can be costly to build. (see Figure 5)

Cost Savings Note: Structures for all SNOUT® systems are non-proprietary and obtained locally from pre-casters or built in place by local contactors. SNOUT® components and designs are low-cost, but are protected by a US Patent with international patents pending. The combination of low-cost components in non-proprietary structures can reduce overall installed systems costs dramatically.

Following are application drawings of the systems mentioned above:

Figure 1- Catch Basin with Hood

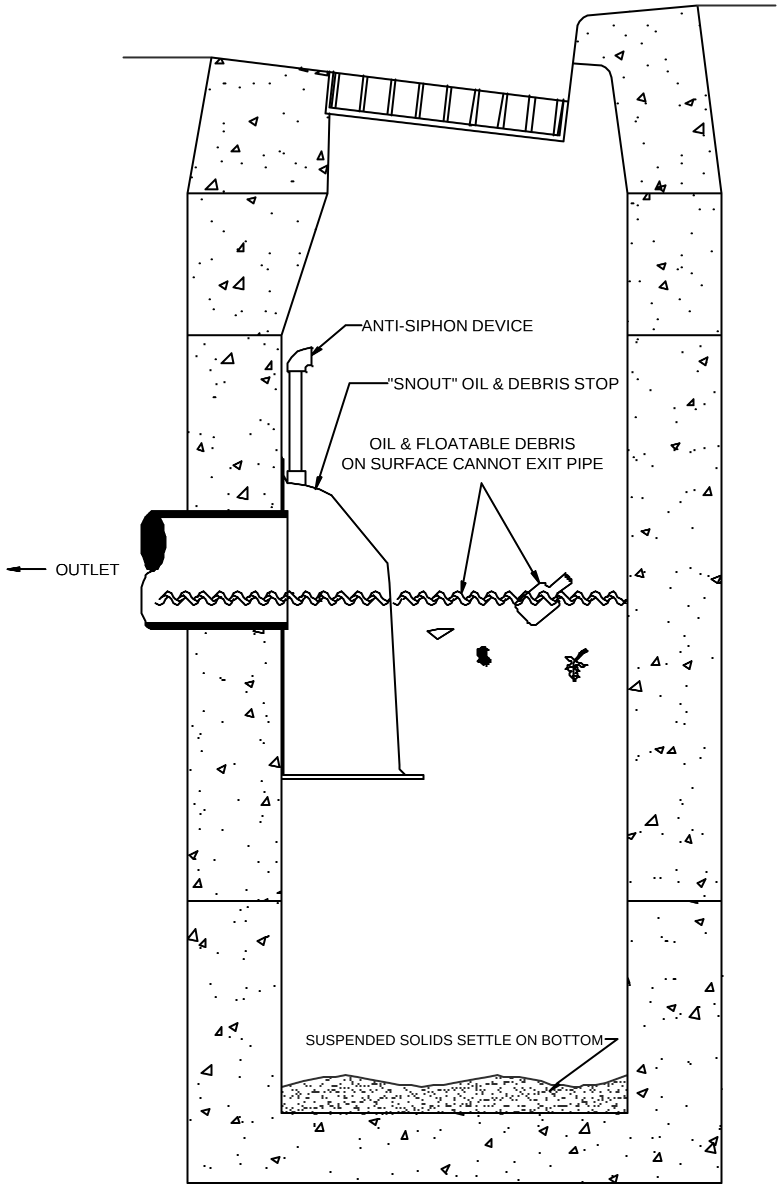
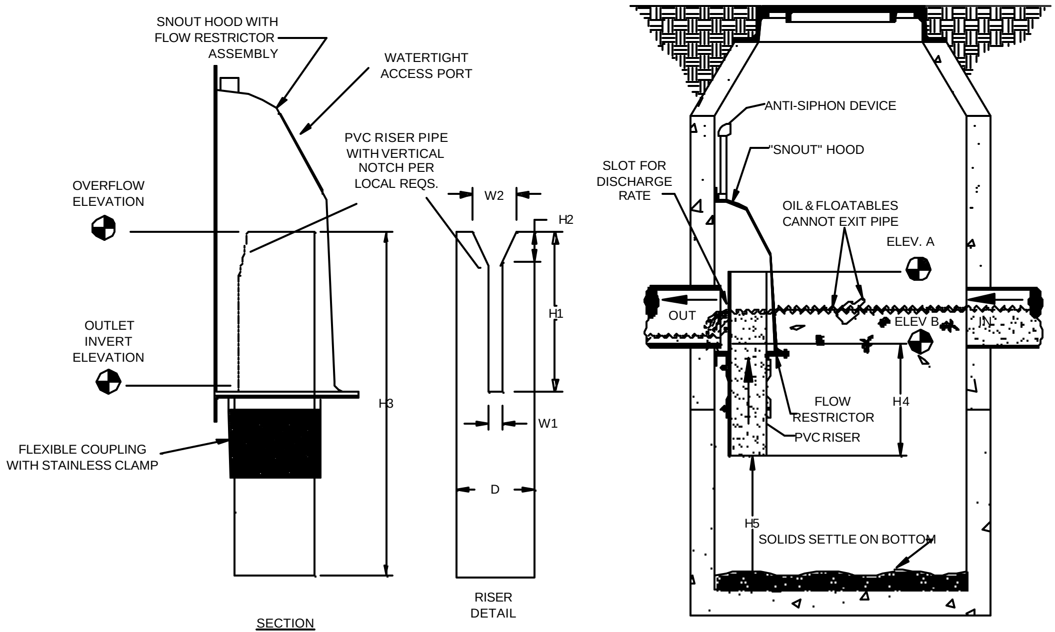


Figure 2- In-line Catch Basin with Hood and Flow Restrictor



DIMENSION REQUIREMENTS

ELEVATION A:________ (OVERFLOW)

ELEVATION B:________ (OUTLET INVERT)

RISER DIMENSIONS

D= RISER ID: _____
W1= SLOT WIDTH: _____
W2= NOTCH WIDTH: _____
H1= SLOT LENGTH: _____
H2= NOTCH LENGTH: _____
H3= RISER LENGTH: _____
H4= SUBMERGE DEPTH: _____ (MIN. 18")
H5= DEPTH TO BOTTOM: _____ (MIN. 24")

HOOD SIZE DETERMINED BY MANUFACTURER BASED ON RISER DIAMETER.

ADDITIONAL SKIRT PIECES AVAILABLE TO INCREASE HEIGHT OF HOOD.

Figure 3- Structures in Series with Oil Absorbents and Deflector Plates

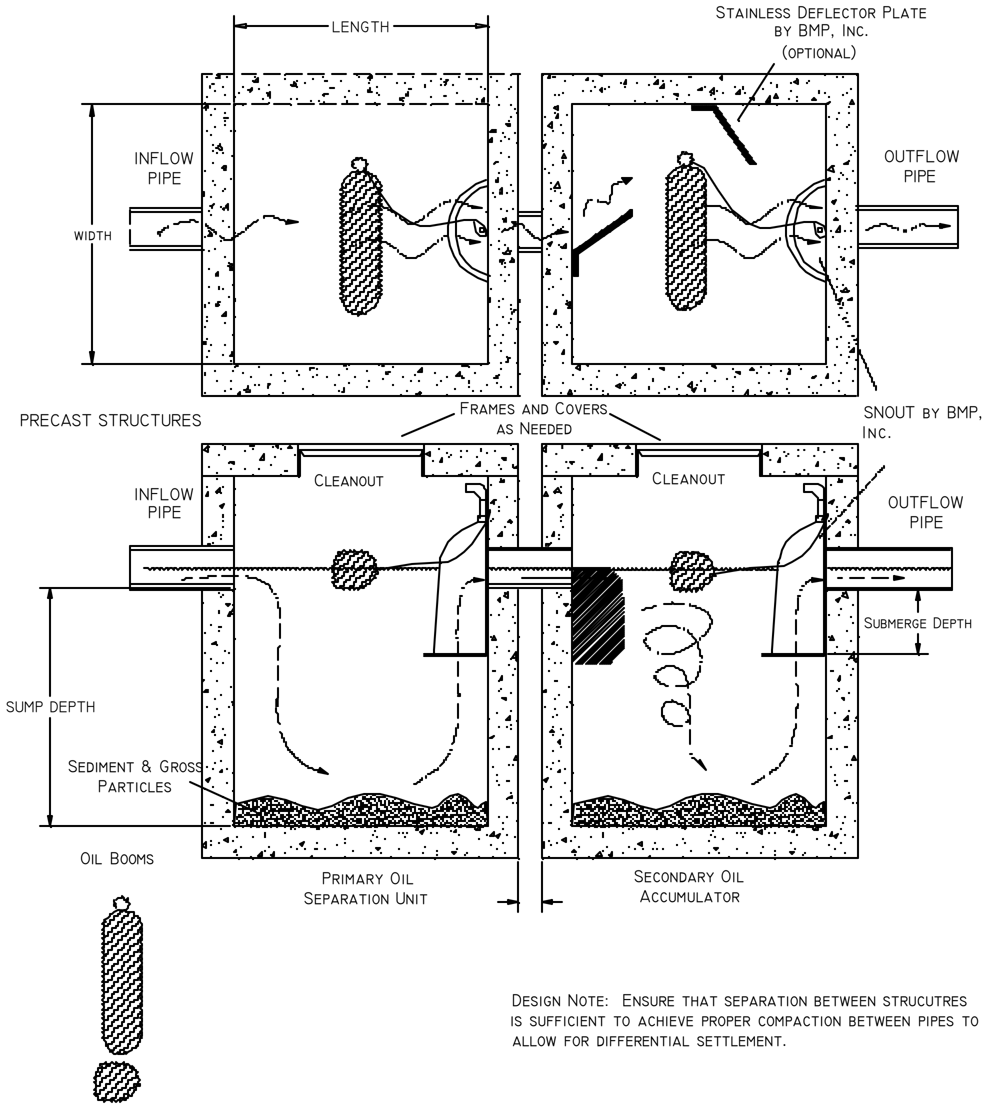


Figure 4- Bypass Structure Configuration

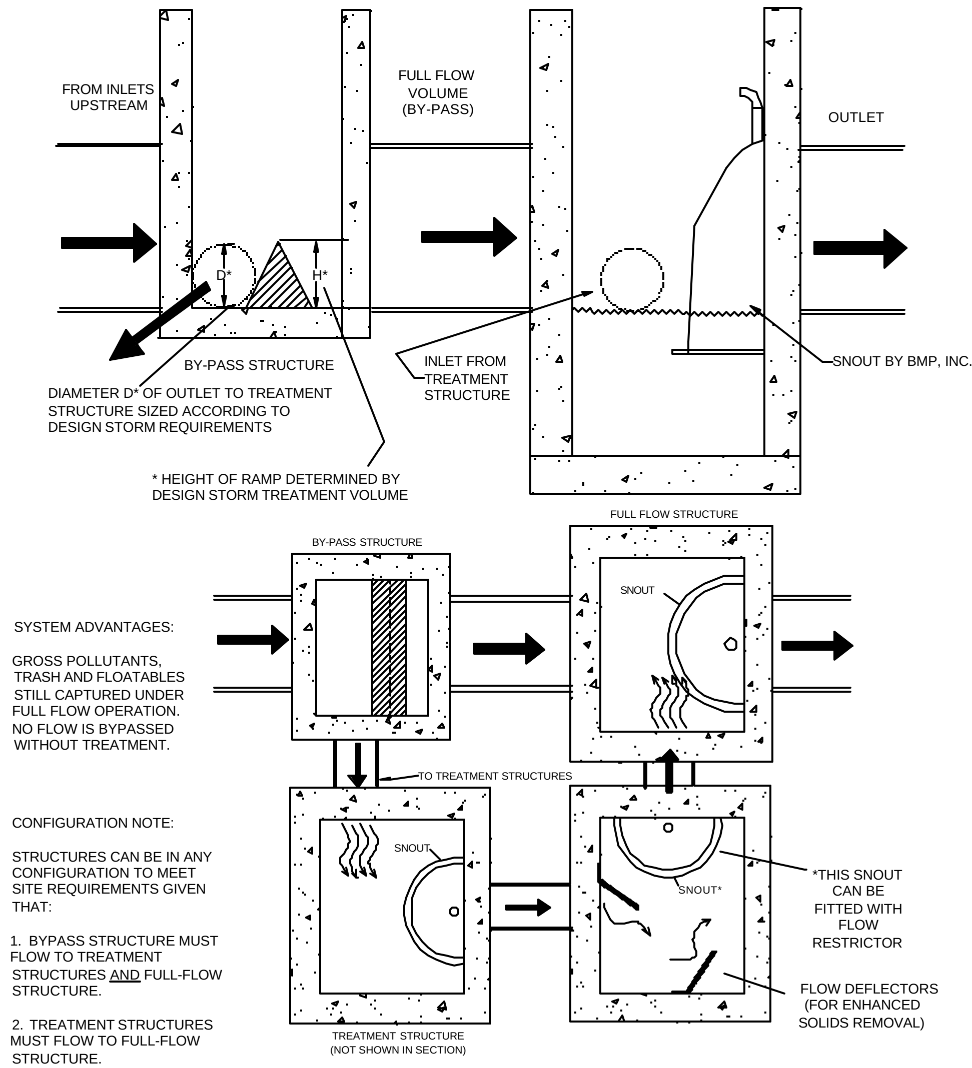
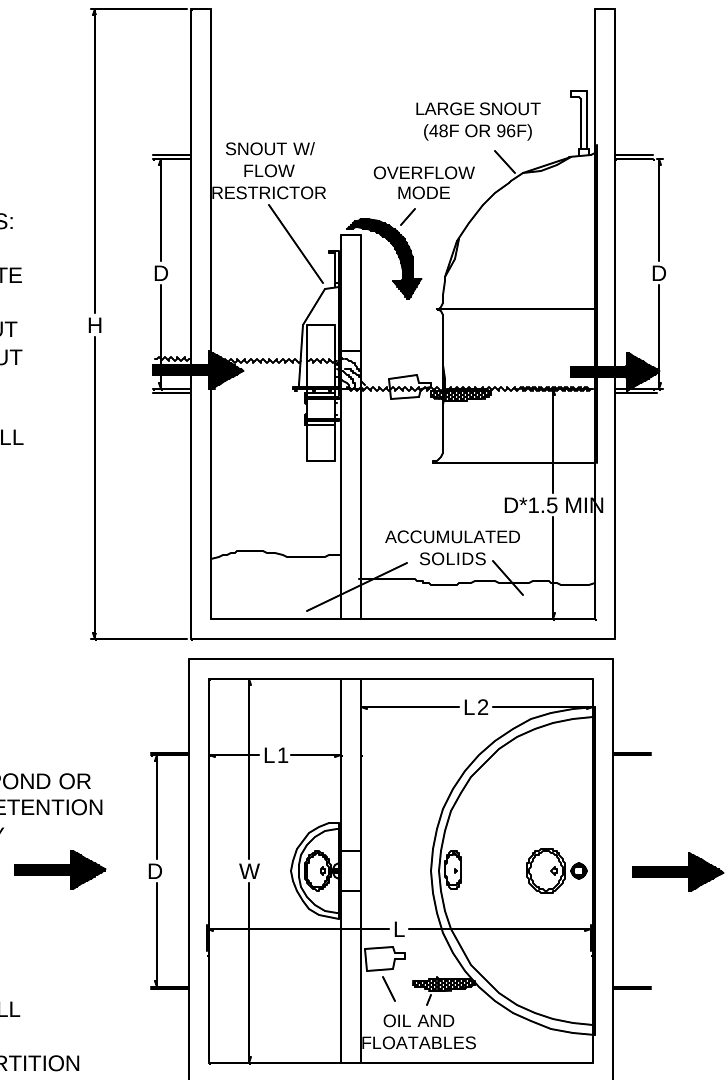


Figure 5- Outlet Structure with Overflow

SYSTEM ADVANTAGES:

FLOW DISCHARGE RATE ACCURATELY CONTROLLED WITHOUT CLOGGING WITH SNOUT FLOW RESTRICTOR

OVERFLOW MODE STILL CONTAINS FLOATING POLLUTANTS



DIMENSIONS:

D= PIPE DIAMETER
H= HEIGHT OVER ALL
L= LENGTH INSIDE
L1= LENGTH TO PARTITION
L2= LENGTH TO BACK WALL
W= WIDTH INSIDE

Design and Maintenance Considerations

The SNOUT® system from BMP, Inc. is based on a vented hood that can reduce floatable trash and debris, free oils, and other solids from stormwater discharges. In its most basic application, a SNOUT® hood is installed over the outlet pipe of a catch basin or other stormwater quality structure which incorporates a deep sump. The SNOUT® forms a baffle in the structure which collects floatables and free oils on the surface of the captured stormwater, while permitting heavier solids to sink to the bottom of the sump. The clarified intermediate layer is forced out of the structure through the open bottom of the SNOUT® by displacement from incoming flow. The resultant discharge contains considerably less unsightly trash and other gross pollutants, and can also offer modest reductions of free-oils and finer solids.

As with any structural stormwater quality Best Management Practice, design and maintenance considerations will have a dramatic impact on SNOUT® system performance over the life of the facility. The most important factor to consider when designing structures which will incorporate a SNOUT® is the depth of the sump (the sump is defined as the depth from beneath the <u>invert of the outlet pipe</u> to the bottom of the structure). Simply put, the deeper the sump, the more effective the unit will be in terms of removing pollutants, preventing resuspension, and reducing frequency of maintenance. More volume in a structure means more quiescence, thus allowing the pollutant constituents a better chance to separate out. Secondly, more volume means fewer cycles between maintenance operations, because the structure has a greater capacity.

Design Notes:

- As a rule of thumb, BMP, Inc. recommends *minimum* sump depths based on outlet pipe <u>inside</u> diameters of 2.5 to 3 times the outlet pipe size.
- Special Note for Smaller Pipes: A minimum sump depth of 36 inches for all pipe sizes 12 inches ID or less, and 48 inches for pipe 15-18 inches ID is required if collection of finer solids is desired.
- The plan dimension of the structure should optimally be 6 to 7 times the flow area of the outlet pipe.

Example Calculation:

A SNOUTÒ equipped structure with a 15 inch ID outlet pipe (1.23 sqft. flow area) will offer an optimal combination of cost-effectiveness and pollution removal with a minimum plan area of 7.4 sqft. and minimum 48 inch sump. Thus, a readily available 48 inch diameter manhole-type structure, or a rectangular structure of 2 feet x 4 feet will offer sufficient size when combined with a sump depth of 48 inches or greater.

Therefore, it follows that larger pipe sizes will require larger structures and/or deeper sumps to maintain optimal effectiveness.

As for long term structural maintenance practices, BMP, Inc. recommends the following:

- Monthly monitoring for the first year of a new installation after the site has been stabilized.
- Measurements of sediment depth and observations of floating pollution should be taken after each rain event of .5 inches or more, or monthly, as determined by local weather conditions.
- Checking sediment depth and noting the surface pollutants in the structure will be helpful in planning maintenance. The pollutants collected in SNOUT® equipped structures will consist of floatable debris and oils on the surface of the captured water, and grit and sediment on the bottom of the structure.
- It is best to schedule maintenance based on the solids collected in the sump. To achieve a reasonable compromise between practicality and pollution removal effectiveness, the structure should be cleaned when the sump is half full (e.g. when 2 feet of material collects in a 4 foot sump, clean it out). The more often it is cleaned, the better the performance will be as the structure will maintain a greater "effective volume." Of course, depending on resources available for maintenance, some performance may have to be sacrificed due to budgetary constraints.
- Structures should also be cleaned if a spill or other incident causes a larger than normal accumulation of pollutants in a structure.
- Maintenance is best done with a vacuum truck.
- If oil absorbent hydrophobic booms are being used in the structure to enhance hydrocarbon capture and removals, they should be checked on a monthly basis, and serviced or replaced when more than 2/3 of the boom is submerged, indicating a nearly saturated state.
- All collected wastes must be handled and disposed of according to local environmental requirements.
- To maintain the SNOUT® hoods themselves, an annual inspection of the anti-siphon vent and access hatch are recommended. A simple flushing of the vent, or gentle rodding with a flexible wire are all that's typically needed to maintain the anti-siphon properties. Opening and closing the access hatch once a year assists a lifetime of trouble-free service.

Further structural design guidelines, maintenance recommendations and site inspection field report sheets are available from BMP, Inc. Please contact us if we can offer further assistance.

Summary

Municipal engineers and stormwater designers are grappling to adapt a pollution control function to traditional drainage systems, recognizing that fundamental changes in traditional stormwater infrastructure design will be required. Presently, the primary function of most MS4s are to evacuate stormwater from point A to point B as quickly and efficiently as possible, often with minimal regard of the impact to receiving waters. As such, compliance with the stormwater quality regulations that are being promulgated across the United States could be difficult for impacted municipalities. Fortunately, implementation of simple design changes, and low-cost technologies, such as those manufactured by Best Management Products, Inc., can make complying with new regulations mandating reductions in the discharge of trash, floatable debris, oil and grease, and sediment easier. Updated structure designs are particularly easy to implement for new construction. In areas where catch basins already have sumps, installing an outlet hood is quick work which can yield substantial benefits. Retrofits to systems without sumped structures, especially at strategic nodes, are still cost-effective as they make the existing conveyance systems more efficient, and can extend the service life of traditional stormwater facilities. While the work remaining to improve our stormwater infrastructure is daunting, the benefits of reducing pollutants from stormwater runoff will be numerous. Benefits include improved surface water quality, reduced impacts to wildlife habitat, and a healthier environment for recreation and enjoyment of our natural resources.

References

Pitt, Robert and Field, Richard. "An Evaluation of Storm Drainage Inlet Devices for Stormwater Quality Treatment." The University of Alabama at Birmingham, Department of Civil and Environmental Engineering, United States Environmental Protection Agency, Wet Weather Flow Research Program, pp. 3-4, 1998.

United States Environmental Protection Agency., Environmental News, "EPA expands controls on polluted runoff to further protect Nation's drinking water and waterways." R-134, p. 1, November, 1999.

HydroQual, Inc., "City-Wide Floatables Study." New York City Department of Environmental Protection, Bureau of Environmental Engineering, Division of Water Quality Improvement. As cited in "CSO Technology Fact Sheet, Floatables Control". United States Environmental Protection Agency, Washington, D. C. Document EPA 832-F99-008, p. 5, September 1999.

Shuck, W., "Waterway trash limits considered", Long Beach Press-Telegram, p. A3, Nov. 29, 2000.

SNOUT® is a registered trademark of Best Management Products, Inc.
53 Mt. Archer Rd., Lyme, CT 06371
Phone: 800-504-8008 Fax: 860-434-3195 Web Site: www.bmpinc.com
The SNOUT® is protected by US Patent # 6126817, international patents pending.